APPENDIX I

ALL PENDING CLAIMS WITH AMENDMENTS EFFECTED THEREIN

1 - 4.(Canceled)

5.(Previously Presented) The vane rotary expander according to any one of claims 7 to 10, wherein the expander is operated by means of an operating fluid expanding into a gas-liquid two phase from a liquid phase or a supercritical phase.

6.(Previously Presented) The vane rotary expander according to any one of claims 7 to 10, wherein the expander is operated by means of an operating fluid containing carbon dioxide as a main component.

7. (Currently Amended) An expander having a plurality of operating chambers for expanding a high-pressure operating fluid and a shaft for obtaining a rotating power by expansion of the operating fluid in the operating chambers comprising:

a first discharge port which firstly communicates to an operating chamber of said operating chambers during a discharging process and a second discharge port which secondly communicates to the same operating chamber during said discharging processing;

a valve mechanism preventing the operating fluid from flowing back into the operating chamber being provided to the first discharge port;

a discharge chamber temporarily storing the operating fluid flowing out from the first and second discharge ports;

the expander being configured to produce a maximum volume pressure (Pc) in the operating chamber when the operating chamber has a maximum volume immediately before the operating chamber begins communication with the first

discharge port, the maximum volume being filled by expansion of the high-pressure operating fluid effecting rotation of said shaft to transmit rotating power;

the expander having a discharge pressure (Pd) in the discharge chamber and the discharge pressure (Pd) being greater than the maximum volume pressure (Pc);

the expander being configured so that the volume of the operating chamber is compressed starting immediately after the operating chamber communicates with the first discharge port and is compressed to a level greater than the dischar ge pressure (Pd) of the discharge chamber to release the valve mechanism; and

the expander having a intake port communicating with the chamber introducing the high-pressure operating fluid into the chamber prior to the chamber expanding to the maximum volume, said intake port being positioned to be out of communication with the operating chamber to end intake of the high pressure operating fluid immediately prior to another operating chamber of said operating chambers, immediately preceding the operating chamber in expansion cycling, reaching the maximum volume.

8. (Currently Amended) A vane rotary expander, comprising:

a cylinder having a cylindrical inner wall;

side plates closing both ends of the cylinder;

a rotor eccentrically disposed in the cylinder and an outer circumference of the rotor defining minimum clearance position whereat a clearance between the cylindrical inner wall of the cylinder and the outer circumference is minimum;

vanes disposed in vane grooves in the rotor so as to be freely slidable, ends of the vanes being in contact with the cylindrical inner wall of the cylinder to form a plurality of operating chambers between the cylinder and the rotor; and

a shaft connected to the rotor and rotatably supported about an axis

a first discharge port which firstly communicates to an operating chamber of said operating chambers during a discharging process and a second discharge port which secondly communicates to the same operating chamber during said discharging processing;

a valve mechanism preventing the operating fluid from flowing back into the operating chamber being provided to the first discharge port;

a discharge chamber temporarily storing the operating fluid flowing out from the first and second discharge ports;

the expander being configured to produce a maximum volume pressure (Pc) in the operating chamber when the operating chamber has a maximum volume immediately before the operating chamber begins communication with the first discharge port, the maximum volume being filled by expansion of the high-pressure operating fluid effecting rotation of said shaft to transmit rotating power;

the expander having a discharge pressure (Pd) in the discharge chamber and the discharge pressure (Pd) being greater than the maximum volume pressure (Pc);

the expander being configured so that the volume of the operating chamber is compressed starting immediately after the operating chamber communicates with the first discharge port and is compressed to a level greater than the dischar ge pressure (Pd) of the discharge chamber to release the valve mechanism; and

the expander having a intake port communicating with the chamber introducing the high-pressure operating fluid into the chamber prior to the chamber expanding to the maximum volume, said intake port being positioned to be out of communication with the operating chamber to end intake of the high pressure operating fluid immediately prior to another operating chamber of said operating chambers, immediately preceding the operating chamber in expansion cycling,

reaching the maximum volume.

9. (Currently Amended) A vane rotary expander including:

a cylinder having a cylindrical inner wall;

side plates closing both ends of the cylinder;

a rotor disposed in the cylinder, an outer circumferential segment of the rotor defining a small clearance together with the inner wall of the cylinder;

vanes inserted into vane grooves formed in the rotor at respective ends thereof so as to be freely slidable, the other ends of the vanes being in contact with the inner wall of the cylinder to form a plurality of operating chambers between the cylinder and the rotor; and

a shaft integrally formed with the rotor , the shaft being rotatably supported about an axis,

wherein a power for rotating the shaft is obtained by expanding a high-pressure operating fluid in the operating chamber, comprising:

a first discharge port firstly communicating to the operating chamber involving in a dischar ging process and a second discharge port secondly communicating to the same operating chamber, both dischar ging ports being provided in the cylinder in a circumferential direction;

a valve mechanism preventing the operating fluid from flowing back being provided to the first discharge port; and

a discharge chamber temporarily storing the operating fluid flowing out from the first and second discharge ports, wherein:

a pressure (Pc) applied to the operating chamber which has a maximum volume immediately before the operating chamber reaches

the first discharge port is set lower than a pressure (Pd) applied to the discharge chamber, and the expander is set so that the volume of the operating chamber is compressed again immediately after the operating chamber reaches the first discharge port to release the valve mechanism when the recompressed pressure exceeds the pressure applied to the discharge chamber; and

a number of the vanes is n, the first discharge port is formed in the cylinder at a position of approximately {180 x (1 + 1/n)} degrees from the small clearance in a direction where the shaft rotates, and the second discharge port is formed in the cylinder at any position in an area from an angle of approximately {180 x (1 + 1/n)} degrees to an angle of 360 degrees from the small clearance in the direction where the shaft rotates.

10.(Previously Presented) The vane rotary expander according to claim 9, wherein a central angle around the shaft on the cylinder between the first discharge port and the second discharge port and/or between the second dischar ge ports is smaller than or equal to (360/n) degrees.

11. (New) A vane rotary expander including:

a cylinder having a cylindrical inner wall;

side plates closing both ends of the cylinder;

a rotor disposed in the cylinder, an outer circumferential segment of the rotor defining a small clearance together with the inner wall of the cylinder;

vanes inserted into vane grooves formed in the rotor at respective ends thereof so as to be freely slidable, the other ends of the vanes being in contact with the inner wall of the cylinder to form a plurality of operating chambers between the cylinder and the rotor; and

a shaft integrally formed with the rotor, the shaft being rotatably supported about an axis,

wherein a power for rotating the shaft is obtained by expanding a high-pressure operating fluid in the operating chamber, comprising:

a first discharge port firstly communicating to the operating chamber involving in a discharging process and a second discharge port secondly communicating to the same operating chamber, both discharging ports being provided in the cylinder in a circumferential direction;

a valve mechanism preventing the operating fluid from flowing back being provided to the first discharge port; and

a discharge chamber temporarily storing the operating fluid flowing out from the first and second discharge ports, wherein:

a pressure (Pc) applied to the operating chamber which has a maximum volume immediately before the operating chamber reaches the first discharge port is set lower than a pressure (Pd) applied to the discharge chamber, and the expander is set so that the volume of the operating chamber is compressed again immediately after the operating chamber reaches the first discharge port to release the valve mechanism when the recompressed pressure exceeds the pressure applied to the discharge chamber; and

the expander is operated by an operating fluid expanding into a gas-liquid two phase from a liquid phase or a supercritical phase.

12. (New) A vane rotary expander including:

a cylinder having a cylindrical inner wall;

side plates closing both ends of the cylinder;

a rotor disposed in the cylinder, an outer circumferential segment of the rotor defining a small clearance together with the inner wall of the cylinder;

vanes inserted into vane grooves formed in the rotor at respective ends thereof so as to be freely slidable, the other ends of the vanes being in contact with the inner wall of the cylinder to form a plurality of operating chambers between the cylinder and the rotor; and

a shaft integrally formed with the rotor, the shaft being rotatably supported about an axis,

wherein a power for rotating the shaft is obtained by expanding a high-pressure operating fluid in the operating chamber, comprising:

a first discharge port firstly communicating to the operating chamber involving in a discharging process and a second discharge port secondly communicating to the same operating chamber, both discharging ports being provided in the cylinder in a circumferential direction;

a valve mechanism preventing the operating fluid from flowing back being provided to the first discharge port; and

a discharge chamber temporarily storing the operating fluid flowing out from the first and second discharge ports, wherein:

a pressure (Pc) applied to the operating chamber which has a maximum volume immediately before the operating chamber reaches the first discharge port is set lower than a pressure (Pd) applied to the

discharge chamber, and the expander is set so that the volume of the operating chamber is compressed again immediately after the operating chamber reaches the first discharge port to release the valve mechanism when the recompressed pressure exceeds the pressure applied to the discharge chamber; and

the expander is operated by an operating fluid containing carbon dioxide as a main component.

13. (New) The vane rotary expander according to claim 8, a number of the vanes is n, the first discharge port is formed in the cylinder at a position of approximately {180 x (1 + 1/n)} degrees from the small clearance in a direction where the shaft rotates, and the second discharge port is formed in the cylinder at any position in an area from an angle of approximately {180 x (1 + 1/n)} degrees to an angle of 360 degrees from the small clearance in the direction where the shaft rotates.

14. (New) The vane rotary expander according to claim 13, wherein a central angle around the shaft on the cylinder between the first discharge port and the second discharge port and/or between the second discharge ports is smaller than or equal to (360/n) degrees.

15. (New) An expander for producing rotary motion from fluid expansion, comprising:

a housing structure defining a cylindrical cavity having a cylindrical inner wall;

a rotor eccentrically disposed in and with respect to the cylindrical cavity and having an outer circumference of the rotor defining minimum clearance position

whereat a clearance between the cylindrical inner wall of the cylinder and the outer circumference of the rotor is minimum, said rotor defining vane grooves;

vanes slidably disposed in said vane grooves and having vane ends contacting the cylindrical inner wall to form a plurality of operating chambers between the cylinder and the rotor which rotate, and expand and contract in volume with rotation of the rotor;

a shaft connected to the rotor and rotatably supporting said rotor;

an intake port disposed in said housing structure, having high-pressure fluid applied thereto, and successively introducing said high-pressure fluid into said operating chambers during a suction process, said operating chambers increasing in volume during said suction process to a volume Vb at a point whereat communication with said intake port ceases;

said high-pressure fluid expanding in said operating chambers to expand said operating chambers to rotate said rotor and expand the operating chambers to a maximum volume Vc;

said intake port being positioned to end communication with said operating chambers when an immediately preceding one of said operating chambers expands to the maximum volume Vc;

a first discharge port disposed in said housing structure which firstly communicates to said operating chambers during a discharging process and a second discharge port which secondly communicates to said operating chambers during said discharging processing, said first and second discharge ports being disposed such that as the rotor rotates, the first discharge port communicates with a given chamber of said plurality of chamber and the second discharge port subsequently communicates with said given chamber while said first discharge port is still in communication with said given chamber and also after said first discharge port ceases being in communication with said given chamber;

a valve mechanism preventing fluid from flowing back into the operating chambers being provided to the first discharge port;

the first and second discharge ports having an external discharge pressure (Pd) and the discharge pressure (Pd) being greater than a pressure (Pc) of expanded fluid in the operating chambers at the maximum volume Vc; and

the first discharge port being positioned so that the operating chambers are compressed starting immediately after the operating chambers communicate with the first discharge port and are compressed to provide a pressure a level greater than the discharge pressure (Pd) to open the valve mechanism.

16. (New) The expander of claim 15 wherein said intake port being positioned to define the volume Vb such that

$$Vb = Vc \times \left(1/R\,max\right)^{1/\kappa}$$

wherein Rmax is a maximum expansion ratio of the high-pressure fluid and κ diabetic coefficient.

17. (New) The expander according to claim 16, wherein a number of the vanes is n, the first discharge port is formed in the housing structure at a position of approximately {180 x (1 + 1/n)} degrees from the minimum clearance position in a rotation direction of the rotor, and the second discharge port is formed in the housing structure at any position in an area from an angle of approximately {180 x (1 + 1/n)} degrees to an angle of 360 degrees from the minimum clearance position in the rotation direction.

18. (New) The expander according to claim 17, wherein an angle subtended by the first discharge port and the second discharge port is smaller than or equal to (360/n) degrees.

19. (New) The expander according to claim 16, further comprising a plurality of second discharge ports including said second discharge port and an angle subtended by the first discharge port and a furthest one of the second discharge ports is smaller than or equal to (360/n) degrees.

20. (New) The expander according to claim 16, wherein the high-pressure fluid expands into a gas-liquid two phase from a liquid phase or a supercritical phase.

21. (New) The expander according to claim 16, wherein the high-pressure fluid includes carbon dioxide as a main component.

22. (New) The expander according to claim 15, wherein an angle subtended by the first discharge port and the second discharge port is smaller than or equal to (360/n) degrees.

23. (New) The expander according to claim 15, further comprising a plurality of second discharge ports including said second discharge port and an angle subtended by the first discharge port and a furthest one of the second discharge ports is smaller than or equal to (360/n) degrees.

24. (New) The expander according to claim 15, wherein the high-pressure fluid expands into a gas-liquid two phase from a liquid phase or a supercritical phase.